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## LIST OF ECOSYSTEM SERVICES

| USE VALUES | | |
|---|---|---|
| **Ecosystem Service** | **Description of service** | **Example** |
| **Supportive Functions and Structure** | **Ecological structures and functions that are essential to the delivery of ecosystem services** | |
| Nutrient processing | The cycling of nutrients, including acquisition and storage, within the biosphere. | Nitrogen cycle; phosphorus cycle; maintenance of soil fertility |
| Primary production | The conversion of sunlight into biomass. | Plant growth |
| Pollination and seed dispersal | Movement of plant genes. | Insect pollination; seed dispersal by animals |
| Habitat | The physical place where organisms reside. | Refugium for resident and migratory species; spawning and nursery grounds |
| Hydrological Cycle | Movement and storage of water through the biosphere. | Evapotranspiration; stream runoff; groundwater retention |
| **Regulating Services** | **Maintenance of essential ecological processes and life support systems for human well-being** | |
| Gas sequestration, storage, and production | Regulation of the chemical composition of the atmosphere and oceans. | Sequestration of carbon dioxide and release of oxygen; vegetative absorption of volatile organic compounds |
| Climate processes | Processes related to regulation of climate from a local to global scale. | Direct influence of land cover on temperature, precipitation, wind, and humidity |
| Storm surge protection | Dampening or reducing environmental impacts from storm surge. | Marshes and other coastal habitats absorbing waters from surge |
| Biological control | Species interactions. | Control of pests and diseases; reduction of herbivory (crop damage) |
| Water flow | Flow of water across the planet's surface. | Modulation of the drought-flood cycle; purification of water |
| Erosion control | Erosion control and sediment retention. | Prevention of soil loss by wind and runoff; avoiding buildup of silt in lakes and wetlands |
| Pollution abatement | Removal or breakdown of non-nutrient compounds and materials, or other forms of potentially harmful pollution. | Pollution detoxification; absorption of noise pollution |

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| Provisioning Services | Provisioning of natural resources and raw materials | |
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| Freshwater provision | Filtering, retention, and storage of freshwater. | Provision of freshwater for drinking; medium for transportation; irrigation |
| Food | Provisioning of edible plants and animals for human consumption. | Hunting and gathering of fish, game, fruits, and other edible animals and plants; small-scale subsistence farming and aquaculture |
| Raw materials | Products harvested from natural resources for human use such as building, manufacturing, energy, fertilizer. | Lumber, skins, plant fibers, oils and dyes; fuel wood, organic matter (ex: peat); topsoil, leaves, litter, excrement |
| Genetic resources | Genetic resources. | Genes to improve crop resistance to pathogens and pests and other commercial applications |
| Medicinal resources | Biological and chemical substances for use in drugs and Pharmaceuticals. | Quinine; Pacific yew; Echinacea |
| Ornamental resources | Resources for fashion, handicraft, jewelry, pets, worship, decoration and souvenirs. | Feathers used in decorative costumes; shells used as jewelry |
| Cultural Services | Enhancing emotional, psychological, and cognitive well-being | |
| Recreation | Opportunities for rest, refreshment, and recreation. | Ecotourism; bird-watching; outdoor sports |
| Aesthetic | Sensory equipment of functioning ecological systems. | Proximity of houses to scenery; open space |
| Science and education | Use of natural areas for scientific and educational enhancement. | A natural field laboratory and reference area |
| Cultural, spiritual and historic | Use of nature for symbolism or representation; natural landscapes/seascapes with significant spiritual, religious, or cultural value. | Oyster middens; burial sites; ancestral lands |

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| NON-USE VALUES | |
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| Bequest | Value people place on knowing that future generations will have the option of using an ecosystem good or service. |
| Existence | Value people place on knowing that a certain ecosystem good or service exists. |
| Option | Value people place on knowing that they have the option of using/benefiting from a certain service or good. |
| **Total Economic Value (TEV)** | Value of all Use and Non-Use Ecosystem Services. |

**Source:** Farber, et al., 2006.

## LIST OF VALUATION METHODS

| VALUATION METHODS | |
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| Avertive or Mitigative Expenditures | Expenditures taken to mitigate or avert the negative effects of the loss of ecosystems or ecosystem services and to avoid consequent economic costs. These expenditures can be used as indicators of the value of conserving habitats in terms of expenditures avoided. |
| Benefit Transfer (BT) | The goal is to estimate benefits for one study by adapting an estimate of benefits from some other study. It is often used when it is too expensive and/or there is little time available to conduct an original valuation study. |
| Choice Experiment (CE) or Discrete Choice Experiment (DCE) | Choice experiments are based on Lancastrian consumer theory which proposes that consumers make choices not on the simple marginal rate of substitution between goods, but based on preferences for attributes of these goods. CE predicts consumers' choice by determining the relative importance of various attributes in consumers' choice process (Hanemann and Kanninen 1998). |
| Contingent Valuation (CV) | People are directly asked their willingness to pay or accept compensation for some change in ecological service. |
| Damage Cost Avoided (DCA or DC) | The damage cost avoided estimate the costs of ecosystem services based on avoiding damages due to lost services. |
| Debt for Nature Swap | Debt for nature swap is an agreement between a developing country with a high financial debt and one or more of its creditors. In this situation, the creditors agree to forgive the debt and in return the nation in debt promises environmental protection of some of its natural resources; historically the environmental promises have focused on the protection of large areas such as tropical rainforests (Wynn, 2011). |
| Delphi Panel | Structured communication technique created as an interactive forecasting method that relies on a panel of experts. This |

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| | method is based on the idea that group judgments are more legitimate than individual judgments. |
| Demand Function | Demand function is a behavioral relationship between the quantity of a product (or service) consumed and a person's maximum willingness to pay for incremental increases in the quantity of such product (or service). Factors that frequently influence willingness-to-pay include income, price or availability of substitutes, and individual tastes or preferences. This behavioral relationship is usually an inverse relationship where higher prices lead to less quantity consumed and vice versa. |
| Discrete Factor Method (DFM) | This method permits us to account for unobserved heterogeneity across agents, while at the same time allowing for correlation across RP and SP demand equations. |
| Emergy | Emergy is a thermodynamic methodology introduced by Howard Odum during the 1980s. This quantitative analysis technique standardizes the values of non-monetized and monetized resources, services and commodities in a sole unit, making it a very versatile technique that can be applied to whatever natural or human system or to a mix of two and that allows measuring the work of the environment and economy on a common basis (Odum and Odum, 2000; Vassallo et al., 2013). |
| Energy Analysis (EA) | This valuation technique looks at the total biological productivity of ecosystems as a measure of their total contributory value. Primary plant production is the basis for the food chain which supports the production of economically valuable products such as fish and wildlife. It is converted to an equivalent economic value based on the cost to society to replace this energy source with fossil fuel as measured by the overall energy efficiency of economic production. |
| Expected Damage Function Approach (EDF) | This method is used when the ecosystem has a protective value, such as the protecting value of coastal wetlands from storms or floods. In this case, the natural resource has a non-marketed service of protection of economic activity, property, or even people's lives by mitigating the storm effects. This method assumes that the value of the ecosystem in reducing economic impacts can be measured by the decrease in expected damages (Hanley & Barbier, 2009). |
| Expenses on Wildlife Habitat | It represents the costs incurred by recreational users of the habitat (Hovde & Leitch, 1994). |
| Hedonic Price Method (HP) | This method is used to value ecosystems or ecosystem services that directly affect market prices. It is commonly used in analyzing variations in house prices that reflect the home owner's willingness to pay for environmental attributes; it can be used to estimate the benefits associated with environmental amenities, such as aesthetics and proximity to recreational locations (King &Mazzotta, 2000). |
| InVEST: Integrated Valuation of Environmental Services and Tradeoffs | InVEST is a set of tools to map and value ecosystem services which are essential for sustaining and fulfilling human life. For more information visit: http://www.naturalcapitalproject.org/InVEST.html. |
| Latent Class Model (LCM) | This method is used to evaluate choice behavior as a function of visible features of the choices and hidden heterogeneity in respondent characteristics. |
| Market Price (MP) | It estimates the economic value of ecosystem products or services that are bought and sold in commercial markets. It uses standard economic techniques for measuring the economic benefits from marketed goods, based on the quantity people purchase at different prices, and the quantity supplied at different prices. |
| Meta-Analysis (MA) | The process or technique of synthesizing research results by using various statistical methods to retrieve, select, and combine results from previous studies. |

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| Meta-Regression (MR) | A statistical model to perform meta-analysis that looks at the relation between values of x (dependent variable) given the observed values of y (independent variable(s)). |
| Multi-Model Criteria Analysis (MCA) | A tool in decision theory that models a decision-maker preferences to choose among options involving a number of, often, conflicting goals. This approach examines how all the significant aspects of choices are assessed and traded-off by decision makers. |
| Multinomial Logit Model (MNL) | This method is used to represent choice between two exclusive options; for example, a person may choose to drive to work and take a bus. The weakness of this model is that is implies that the choice between any two alternatives depends only on the characteristics of the alternatives being compared, rather than the characteristics of any other group of alternatives. |
| Opportunity Cost | The loss of potential gain from other alternatives when one alternative is chosen. In short, the benefits an individual would receive by choosing another action/buying another product. |
| Productivity Method (PM) | Estimates economic values for ecosystem products or services that are bought and sold in commercial markets. |
| Random Utility Model (RUM) | This method is used in travel cost recreation demand analysis to value features of the recreational sites. For example, this method can be used to value the benefits of improved access to beach or improved water quality for recreational purposes. The travel cost RUM analyzes a person's discrete choice of one recreation site over other sites. The site choice is assumed to depend on the features of the site and to reveal the person's preferences for those features. |
| Regression Analysis (RA) | The description of the nature of the relationship between two or more variables; it is concerned with the problem of describing or estimating the value of the dependent variable on the basis of one or more independent variables. |
| Relative Ratings | In this method individuals rate natural resources as a means of estimating its value. If a wetland provides fish for example and fish is highly valued, then they would rate the wetland with a 5, which would represent the highest level of relative importance. |
| Replacement Cost (RC) | The loss of a natural system service is evaluated in terms of what it would cost to replace that service. |
| Revealed Preference | This theory is based on the idea that the preferences of consumers can be revealed by their purchasing habits. Two methods that follow in this category are Travel Cost Method (TC) and Hedonic Price (HP). |
| Shadow Price (SP) | Shadow price is a proxy value of a good, usually defined as what an individual must give up to gain an extra unit of that good. When the price of a good or service does not reflect the actual value of that good or service, or when there is no market for that good or service, shadow price can be used. Economists also use the term *shadow price* to refer to *opportunity cost.* |
| Stated Preference | This technique is a market research tool that allows researchers to understand how consumers value different ecosystem products and/or services. It involves asking consumers to rate, rank, or how much they would be willing to pay or accept for a certain ecosystem good or service. The choices made by consumers help determine how they value a certain product or service. Examples of this technique include contingent valuation, conjoint analysis, and choice experiment. |
| Travel Cost Method (TC) | Estimates economic values associated with ecosystems or sites that are used for recreation. Assumes that the value of a site is reflected in how much people are willing to pay to travel to the site. |
| Willingness-to-Pay (WTP) | Asks people to directly state their willingness to pay for specific environmental services, based on a hypothetical scenario. |

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**DEFINITION OF EACH COLUMN IN THE RESULTS TABLE**

| Column | Definition |
|---|---|
| Type of habitat | We have created tables for the following ecosystems: coastal freshwater marsh, saltwater marsh, marine and open waters, coral reefs, beach, seagrass, oyster, dunes, mangroves, barrier island, and estuary. |
| Service | This tells us the ecosystem service being valued (e.g. recreation, food, etc). |
| Adjusted Values | This shows the value adjusted to 2019 US dollars. |
| Units | This shows the units used (e.g. per ha/ per year, per visitor/ per visit, etc). |
| Country/ Region | This column indicates the country or region in which the study was done. |
| State/ Province | This shows the state or province in which the study was done. If the study was done outside the U.S., then it shows the city or area where it was done, depending upon the information provided in the study. |
| Method | This shows the method used in the study to assign a monetary to the specific ecosystem service. |
| Author | This column shows the first author's last name and the year of publication. |
| Link to source | This column shows the Digital Object Identifier (DOI) or link to source if DOI not provided, used to identify an article or document and link to it on the web, also could include ISBN or ISSN. |

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